ISR PERFORMANCE REPORT

Run 974 - 11.09.1978

Ring 1 Ring 2 26 GeV/c

PFW CURRENTS FOR THE SC LOW-β SCHEME IN I8

1. Summary

The purpose of this experiment was to check the possibility of operating the superconducting low-β scheme (SLBS) in I8 at 31 GeV.

From the results of a similar experiment in 1977[1] we can deduce that some PFW currents get saturated during acceleration with SLBS.

However, the sextupole scheme[2] which was studied in ref. 1 has been modified in order to reduce the SC sextupole currents[3], and the SF and SD sextupoles of the ISR have been included in order to avoid saturation of the PFW currents.

The feasibility of this scheme has been demonstrated for Ring 1 and the results obtained for Ring 2 show that no trouble should arise. The conclusion is that the superconducting low-β scheme can be operated in I8 at 31 GeV with the present equipment of the ISR, the luminosity being 9% lower than quoted in ref. 2 (3).

2. Experiment

2.1 Numerical computations (AGS program)

- The low-β scheme proposed in ref. 2 has been put in I8.
- The SC sextupoles have been recomputed so as to maximize the useful aperture of the machine in both rings[3].
- The SF and SD sextupoles of the ISR have been excited in order to reduce the load on the PFW according to the results of ref. 1 (PFW currents calculated by means of the program POLEF[4]).

- The magnets of the insertion have been removed; the "bare machines" so obtained, which are built by means of the main magnets and the SF and SD sextupoles, are characterized by the tunes :

Ring 1
$$\begin{cases} Q_h = 8.736 & Q'_h = 0.97 & Q''_h = -17.8 \\ Q_v = 8.524 & Q'_v = 3.51 & Q''_v = -18.5 \end{cases}$$

Ring 2
$$\begin{cases} Q_h = 8.736 & Q'_h = 1.04 & Q''_h = -20.7 \\ Q_v = 8.524 & Q'_v = 3.55 & Q''_v = -19.2 \end{cases}$$

The difference between the two rings comes from the difference in the increments to be added to the PFW currents during stacking and acceleration.

2.2 Machine experiment (building of the machine with the above tunes)

Since the working lines associated with the above values of the tunes cross the half integer resonance (see fig. 1), a vertical Q-shift of 0.07 has been applied in order to obtain lines with all Q_v above 8.5 : they are called preparation lines. The currents needed to build those lines are listed in table 1 for both rings. The automatic measurement of the line is shown for Ring 1 in fig. 2 (between - 36 and + 40).

For building those lines, a special attention has been paid to the currents of PFF1 PFF12 PFD1 PFD12 : they have been systematically reduced and this reduction compensated by the excitation of the closest winding. As this procedure takes a certain time it has only been completed for Ring 1.

Once the preparation lines have been built, a pulse was placed a little above the central orbit and a vertical Q-shift of - 0.07 was applied : the values of Q_v above 8.5 were checked by means of this pulse, usually they did not differ from the theoretical values. A pulse was then injected for the measurements of the values of Q_v below 8.5; usually Q''_v must be increased by 20 and Q''_h by 10 in order to obtain the theoretical values of Q_h and Q_v.

3. Results

The currents of the auxiliary power supplies of the ISR needed for the preparation lines have been put in the files 3BS1 (Ring 1) and LBS2 (ring 2); they are listed in table 1.

The currents for the superconducting bare machine have been accurately measured only for Ring 1, they are listed in table 2. The difference between those currents and the currents of the file 3BS1 gives the increments between preparation line and bare machine line, they have been used to compute the currents of the bare machine in Ring 2 (see table 5).

The increments of the PFW currents after stacking have been obtained from standard files and can be computed from the values listed in table 3, the results are given in table 5 (column : space charge compensation).

The increments of the PFW currents for acceleration have been obtained from standard files (see table 4), they must be over estimated because they are related to the steel low-β case in which no sextupoles are present in the insertion.

The increments which must be added to the PFW currents of the superconducting bare machines for stacking and acceleration are summarized in table 5. In Ring 1 the situation is comfortable. The experience gained in establishing it allows to state that the overloading appearing in Ring 2 on PFD1 for stacking 30A at 31 GeV can be easily eliminated by powering PFD2.

A. Verdier

References :

1) ISR Performance Report ISR-BOM/AV/ab, 06.12.1977, PFW currents for the SC low-β machine, Run 898.

2) A. Verdier, Division Report, CERN ISR-BOM/77-57.

3) A. Verdier, Note to be published

4) K. Brand, Private communication.

Table 1 - Currents for the preparation lines

```
/XOUT(IF=LBS2,R2,AU)    TIME:00H10M03S    DATE:78-09-12
/XKEE-RUN:974    XINP/XKEE-TIME:00H09M39S    DATE:78-09-12
/OT
   2CP      +42.68      2SF      +26.61      2SD      -51.46
   2SC536    +0.15
/PF
   2PFF1    -37.04      2PFF2    -28.37      2PFF3     -8.06
   2PFF4     -7.76      2PFF5     -6.49      2PFF6     -2.56
   2PFF7     -1.61      2PFF8     +1.59      2PFF9    +10.38
   2PFF10   +10.06      2PFF11   +26.12      2PFF12   +19.34
   2PFD1    -46.92      2PFD2     -2.54      2PFD3     +9.67
   2PFD4     +8.54      2PFD5     +6.18      2PFD6     -5.81
   2PFD7    -10.86      2PFD8     -7.32      2PFD9    -12.52
   2PFD10   -16.04      2PFD11    +2.37      2PFD12   -35.69
/H
   2H216A    +2.86      2H216B    +7.03      2H248     +2.34
   2H300     +0.10      2H352     -1.83      2H316     +3.03
   2H448     +0.88      2H416     -1.39      2H552     +3.76
   2H516     +0.39      2H616     +2.69      2H648     -0.15
   2H752     +3.10      2H716     +0.83      2H848     +4.83
   2H816     +2.59      2H152     +0.83      2H116     +0.02
/CR
   2CR236    +0.02      2CR260   +13.65      2CR344    +0.05
   2CR356    +0.07      2CR404    +0.05      2CR420    +0.02
   2CR436    +0.05      2CR460    +0.05      2CR508    +0.02

   2CR544    -0.07      2CR604    +0.05      2CR636    +0.05
   2CR744    +0.02      2CR756    +0.05      2CR804    +8.25
   2CR120    -0.05      2CR220    +0.05
/SD
   2LBC2    +53.74      2LBC4     +67.02
/QS
   2QS1      -4.00      2QS2      -3.98      2QS4      -4.00
   2QS7      -3.98
/LB
/EM
/SFM
   2TRIM   +21.835      SCM2     +59.230      LCM2     +59.790
/ END OF DATA
```

Ring 2

Q_h = 8.736

Q'_h = 1.04

Q''_h = - 20.7

Q_v = 8.524

Q'_v = 3.55

Q''_v = - 19.2

```
/XOUT(IF=3BS1,R1)    TIME:17H08M22S    DATE:78-09-11
/XKEE-RUN:974    XINP/XKEE-TIME:17H07M25S    DATE:78-09-11
/MAIN
   1WL     LBAC
/OT
   1CP      +42.70      1SF      +46.95      1SD      -35.47
/PF
   1PFF1    +10.79      1PFF2     -5.27      1PFF3     -4.98
   1PFF4     -5.98      1PFF5     -4.64      1PFF6     -2.71
   1PFF7     -4.27      1PFF8     -3.12      1PFF9     +5.30
   1PFF10    +6.54      1PFF11   +17.97      1PFF12   +16.14
   1PFD1     -1.59      1PFD2    -24.22      1PFD3     +2.08
   1PFD4     -1.07      1PFD5     -1.20      1PFD6     -4.96
   1PFD7     -9.23      1PFD8     -6.88      1PFD9     -6.47
   1PFD10    -8.03      1PFD11   +11.43      1PFD12    -7.13
/H
   1H749B    +7.86      1H117    +22.71      1H333     +9.62
   1H349     -7.03
/CR
   1CR729   -29.20
/SD
/QS
   1QS1      +0.37      1QS2      -6.37      1QS3      -1.12
   1QS4      -1.71      1QS5      -5.86      1QS6      +3.83
   1QS7      -4.74
/LB
/EM
/SFM
   1TRIM   +22.060      SFM      -84.782      SCM1     +59.181
   LCM1    +59.682
/ END OF DATA
```

Ring 1

Q_h = 8.736

Q'_h = 0.97

Q''_h = - 17.8

Q_v = 8.524

Q'_v = 3.51

Q''_v = - 18.5

Table 2 - Ring 1 Currents of the superconducting bare machine

```
/XOUT(IF=XLIS,R1)    TIME:17H41M10S     DATE:78-09-11
/XKEE-RUN:974    XINP/XKEE-TIME:17H41M01S    DATE:78-09-11
/MAIN
   1WL     LBAC
/OT
   1CP      +42.70       1SF      +46.95       1SD      -35.47
/PF
   1PFF1    +12.67       1PFF2     -7.74       1PFF3     -7.81
   1PFF4     -9.30       1PFF5     -7.74       1PFF6     -6.69
   1PFF7     -7.30       1PFF8     -5.54       1PFF9     +2.76
   1PFF10    +4.49       1PFF11   +15.53       1PFF12   +13.43
   1PFD1    -32.62       1PFD2    -40.16       1PFD3     -4.25
   1PFD4     -6.67       1PFD5     -7.15       1PFD6    -10.60
   1PFD7    -15.26       1PFD8    -11.06       1PFD9     -8.76
   1PFD10    -8.62       1PFD11   +10.69       1PFD12    -0.07
/H
   1H749B    +7.86       1H117    +22.56       1H333     49.62
   1H349     -7.03
/CR
   1CR729   -29.20
/SO
/QS
   1QS1      +0.37       1QS2      -6.37       1QS3      -1.12
   1QS4      -1.71       1QS5      -5.86       1QS6      +3.83
   1QS7      -4.74
/LB
/EM
/SFM
   1TRIM    +22.052      SFM      -84.782      SCM1     +59.181
   LCM1     +59.680
/ END OF DATA
```

Table 3 - Table for computation of the increments needed for stacking

```
/XOUT(IF=DA26,PF)    TIME:09H29M12S     DATE:78-08-10
/XKEE-RUN:961    XINP/XKEE-TIME:08H55M54S     DATE:78-08-09
/PF
   1PFF1    +22.34       1PFF2    +15.16       1PFF3     -3.15
   1PFF4     +2.83       1PFF5     +5.54       1PFF6     +2.49
   1PFF7     +0.85       1PFF8     +5.35       1PFF9    +11.13
   1PFF10   +15.87       1PFF11   +26.25       1PFF12   +42.07
   1PFD1    -39.21       1PFD2     -5.49       1PFD3     +4.37
   1PFD4     +9.52       1PFD5    +12.16       1PFD6    +12.84
   1PFD7    +12.40       1PFD8    +16.99       1PFD9    +20.63
   1PFD10   +12.92       1PFD11   +31.69       1PFD12   +34.37
   2PFF1     -2.64       2PFF2     +4.44       2PFF3     -6.13
   2PFF4     -0.88       2PFF5     +1.88       2PFF6     +0.88
   2PFF7     -0.32       2PFF8     +4.98       2PFF9    +10.64
   2PFF10   +15.31       2PFF11   +25.83       2PFF12   +41.43
   2PFD1    -42.65       2PFD2    -10.77       2PFD3     +3.42
   2PFD4    +13.89       2PFD5    +13.01       2PFD6    +14.38
   2PFD7    +15.04       2PFD8    +20.26       2PFD9    +23.39
   2PFD10   +14.38       2PFD11   +33.11       2PFD12   +34.47
/ END OF DATA
/XOUT(IF=BAS1,PF,R1)    TIME:09H29M58S     DATE:78-08-10
/XKEE-RUN:961    XINP/XKEE-TIME:21H25M57S     DATE:78-08-08
/PF
   1PFF1    +24.80       1PFF2    +13.99       1PFF3     -5.00
   1PFF4     +0.78       1PFF5     +3.59       1PFF6     +1.54
   1PFF7     +1.22       1PFF8     +4.03       1PFF9     +8.81
   1PFF10   +13.21       1PFF11   +22.88       1PFF12   +34.40
   1PFD1    -29.49       1PFD2     -5.08       1PFD3     +0.98
   1PFD4     +4.17       1PFD5     +7.35       1PFD6     +7.35
   1PFD7     +7.13       1PFD8    +13.18       1PFD9    +18.33
   1PFD10   +12.26       1PFD11   +31.54       1PFD12   +39.45
/ END OF DATA
/XOUT(IF=BAS2,PF,OT)    TIME:09H30M23S     DATE:78-08-10
/XKEE-RUN:961    XINP/XKEE-TIME:17H54M13S     DATE:78-08-07
   2PFF1     -2.66       2PFF2     +1.44       2PFF3     -9.59
   2PFF4     -5.03       2PFF5     -2.03       2PFF6     -1.98
   2PFF7     -1.59       2PFF8     +2.56       2PFF9     +7.28
   2PFF10   +11.87       2PFF11   +21.75       2PFF12   +33.69
   2PFD1    -43.43       2PFD2    -14.97       2PFD3     -1.56
   2PFD4     +7.08       2PFD5     +6.62       2PFD6     +7.93
   2PFD7     +8.69       2PFD8    +15.41       2PFD9    +20.34
   2PFD10   +13.43       2PFD11   +32.54       2PFD12   +40.36
/ END OF DATA
```

Ring 1

PFW currents after stacking 30A

Ring 2

Ring 1

PFW currents before stacking 30A

Ring 2

```
/XOUT(IF=F265,R2)    TIME:09H40M04S     DATE:78-08-10
/XKEE-RUN:911    XINP/XKEE-TIME:06H14M21S     DATE:78-03-10
/MAIN
   2GEV    +26.5911     2DVM    +76.495
   2WL     F265
/OT
   2QT2     -10.72      2CP      +42.48      2QT1     +23.85
   2QT8     +37.92      2QT3      -4.49      2QT4     +17.68
   2QT5      +7.93      2SF      +54.59      2SD      +44.97
   2QT6     +32.91      2QT7      +3.32      2SC536   -14.99
/PF
   2PFF1     -6.23      2PFF2     +2.71      2PFF3     -6.86
   2PFF4     -1.51      2PFF5     +1.17      2PFF6     +0.56
   2PFF7     +0.93      2PFF8     +5.22      2PFF9     +9.74
   2PFF10   +13.28      2PFF11   +23.14      2PFF12   +33.45
   2PFD1    -40.89      2PFD2    -10.42      2PFD3     +2.05
   2PFD4    +11.13      2PFD5    +10.50      2PFD6    +10.64
   2PFD7    +10.86      2PFD8    +17.26      2PFD9    +21.31
   2PFD10   +13.57      2PFD11   +32.81      2PFD12   +36.74
/H
   2H316     +8.35      2H616     -8.01      2H716     -7.06
/CR
   2CR332    -5.05      2CR344    -9.59      2CR404    -3.34
   2CR508   -10.72      2CR620    +7.89
/SO
/QS
/LB
   2LBQ2    +83.42      2LBQ4    -65.84      2LBQ6    +63.70
   2LBQ8    +62.38      2LBQ10   -82.98
/EM
/SFM
/ END OF DATA
/XOUT(IF=F314,R2)    TIME:09H40M22S     DATE:78-08-10
/XKEE-RUN:916    XINP/XKEE-TIME:11H48M48S     DATE:78-03-10
/MAIN
   2GEV    +31.4263     2DVM    +99.997
   2WL     F314
/OT
   2QT2     -12.67      2CP      +99.95      2QT1     +28.25
   2QT8     +44.90      2QT3      -5.30      2QT4     +20.92
   2QT5      +9.35      2SF      +64.58      2SD      +53.12
   2QT6     +38.92      2QT7      +3.91      2SC536   -17.80
/PF
   2PFF1    -39.84      2PFF2    +20.85      2PFF3    +12.30
   2PFF4    +22.02      2PFF5    +30.52      2PFF6    +43.85
   2PFF7    +49.58      2PFF8    +66.16      2PFF9    +80.20
   2PFF10   +62.40      2PFF11   +88.84      2PFF12   +95.43
   2PFD1    -92.41      2PFD2    -39.06      2PFD3     +2.20
   2PFD4    +36.77      2PFD5    +36.04      2PFD6    +37.94
   2PFD7    +51.32      2PFD8    +69.46      2PFD9    +82.47
   2PFD10   +54.91      2PFD11   +91.06      2PFD12   +89.04
/H
   2H316     +8.35      2H616     -8.01      2H716     -7.06
/CR
   2CR332    -5.05      2CR344    -9.62      2CR404   -20.36
   2CR508   -11.72      2CR544    +6.01      2CR604    +3.47
   2CR620   +10.40      2CR636    +6.01      2CR204    -5.00
/SO
```

```
/XOUT(IF=A265,R1)    TIME:09H38M32S     DATE:78-08-10
/XKEE-RUN:911    XINP/XKEE-TIME:10H45M20S     DATE:78-03-23
/MAIN
   1GEV    +26.5898     1DVM    +76.520
   1WL     LBAC
/OT
   1QT2      +2.05      1CP      +47.17      1QT1     +32.23
   1QT8     +26.17      1QT3      +0.32      1QT4     +19.12
   1QT5     -20.21      1SF      +55.32      1SD      +18.80
   1QT6     +29.52      1QT7      +0.56      1SC233   -22.00
/PF
   1PFF1    +23.73      1PFF2    +13.67      1PFF3     -5.18
   1PFF4     +0.46      1PFF5     +3.25      1PFF6     +1.22
   1PFF7     +0.95      1PFF8     +3.76      1PFF9     +8.50
   1PFF10   +12.94      1PFF11   +22.73      1PFF12   +33.81
   1PFD1    -28.27      1PFD2     -4.54      1PFD3     +0.98
   1PFD4     +3.98      1PFD5     +7.13      1PFD6     +7.23
   1PFD7     +6.86      1PFD8    +12.79      1PFD9    +17.99
   1PFD10   +12.06      1PFD11   +31.37      1PFD12   +39.45
/H
   1H749B    +8.06      1H117    +12.79      1H317     +8.06
   1H349     +3.69
/CR
   1CR761    +5.98      1CR861    -3.37      1CR145    -2.76
   1CR249    -9.01      1CR345   +14.43      1CR625    -4.35
/SO
   1LBC1    +47.41      1LBC3    +59.91
/QS
/LB
   1LBQ1    +82.20      1LBQ3    -72.27      1LBQ5    +69.04
   1LBQ7    +62.72      1LBQ9    -83.01
/EM
/SFM
/ END OF DATA
/XOUT(IF=A314,R1)    TIME:09H39M21S     DATE:78-08-10
/XKEE-RUN:911    XINP/XKEE-TIME:11H10M53S     DATE:78-05-11
/MAIN
   1GEV    +31.4304     1DVM    +100.001
   1WL     A314
/OT
   1QT2      +2.29      1CP      +99.37      1QT1     +38.06
   1QT8     +30.83      1QT3      +0.39      1QT4     +22.58
   1QT5     -23.88      1SF      +65.28      1SD      +22.19
   1QT6     +34.64      1QT7      +0.66      1SC233   -26.00
/PF
   1PFF1    -57.40      1PFF2    +23.36      1PFF3    +30.76
   1PFF4    +25.07      1PFF5    +26.71      1PFF6    +44.60
   1PFF7    +51.39      1PFF8    +66.46      1PFF9    +81.32
   1PFF10   +66.53      1PFF11   +85.55      1PFF12   +95.00
   1PFD1    -40.77      1PFD2     -6.96      1PFD3     +9.25
   1PFD4    +24.88      1PFD5    +30.49      1PFD6    +37.23
   1PFD7    +47.07      1PFD8    +62.38      1PFD9    +74.34
   1PFD10   +61.77      1PFD11   +89.36      1PFD12   +88.26
/H
   1H749B    +8.06      1H117    +12.79      1H317     +8.06
   1H349     +3.69
/CR
   1CR761   -14.50      1CR861    -3.37      1CR145    -5.47
   1CR249    -9.01      1CR345   +14.43      1CR305    -9.01
   1CR561   -12.01      1CR625    -4.35
/SO
   1LBC1    +47.41      1LBC3    +59.84
/QS
```

Table 4 - Table for computation of the increments of the PFW needed for acceleration in both rings

TABLE 5

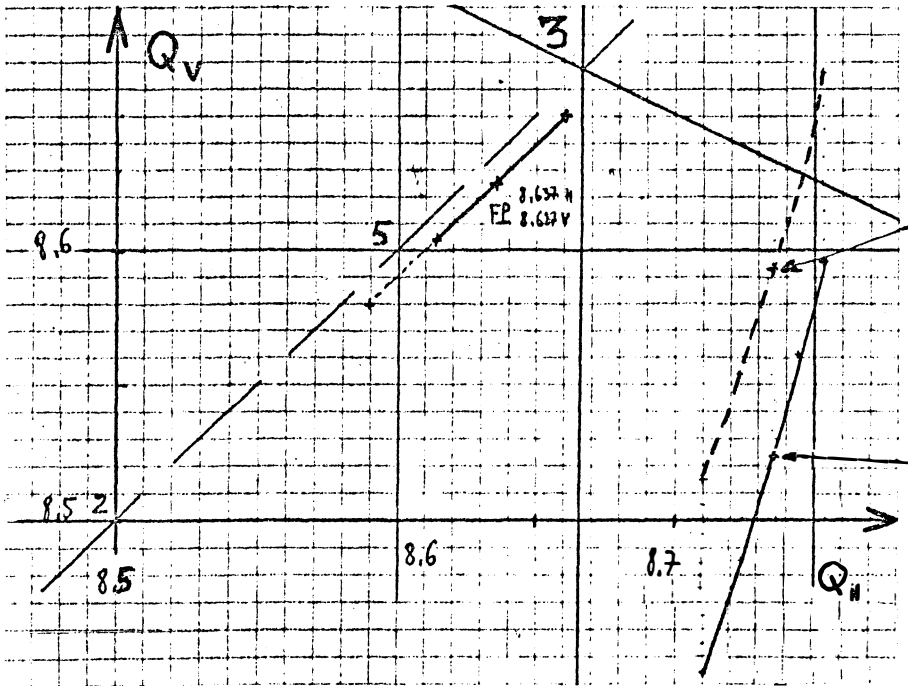
Currents for the superconducting low-β machine

Ring 1	Currents for the preparation line (from Table 1)	Increments for $\Delta Q_v = -0.07$ (Tables 1 & 2)	Superconducting bare machine (Table 2)	Incr. for space charge compens. (from Table 3)	Increments for acceleration (from Table 4)	PFW currents for 30 A at 31 GeV
1 PFF1	+ 10.79	+ 1.88	+ 12.67	- 2.46	- 81.13	- 70.92
2	- 5.27	- 2.47	- 7.74	+ 1.17	+ 9.69	+ 3.12
3	- 4.98	- 2.83	- 7.81	+ 1.85	+ 35.94	+ 29.98
4	- 5.98	- 3.32	- 9.30	+ 2.05	+ 24.61	+ 17.36
5	- 4.64	- 3.10	- 7.74	+ 1.95	+ 10.46	+ 4.67
6	- 2.71	- 3.98	- 6.69	+ 0.95	+ 43.38	+ 37.64
7	- 4.27	- 3.03	- 7.30	- 0.37	+ 50.44	+ 42.77
8	- 3.12	- 2.42	- 5.54	+ 1.32	+ 62.70	+ 58.48
9	+ 5.30	- 2.54	+ 2.76	+ 2.32	+ 72.82	+ 77.90
10	+ 6.54	- 2.05	+ 4.49	+ 2.66	+ 53.59	+ 60.74
11	+ 17.97	- 2.44	+ 15.53	+ 3.37	+ 62.82	+ 81.72
12	+ 16.14	- 2.71	+ 13.43	+ 7.67	+ 61.19	+ 82.29
1 PFD1	- 1.59	- 31.03	- 32.62	- 9.72	- 12.50	- 54.84
2	- 24.22	- 15.94	- 40.16	- 0.41	- 2.42	- 42.99
3	+ 2.08	- 6.33	- 4.25	+ 3.39	+ 8.27	+ 7.41
4	- 1.07	- 5.60	- 6.67	+ 5.35	+ 20.90	+ 19.58
5	- 1.20	- 5.95	- 7.15	+ 4.81	+ 23.36	+ 21.02
6	- 4.96	- 5.64	- 10.60	+ 5.49	+ 30.00	+ 24.89
7	- 9.23	- 6.03	- 15.26	+ 5.27	+ 40.21	+ 30.22
8	- 6.88	- 4.18	- 11.06	+ 3.81	+ 49.59	+ 42.34
9	- 6.47	- 2.29	- 8.76	+ 2.30	+ 56.35	+ 49.89
10	- 8.03	- 0.59	- 8.62	+ 0.66	+ 49.71	+ 41.75
11	+ 11.43	- 0.74	+ 10.69	+ 0.15	+ 57.99	+ 68.83
12	- 7.13	+ 7.06	- 0.07	- 5.08	+ 48.81	+ 43.66

TABLE 5 cont'd

Currents for the superconducting low-β machine

Ring 2	Currents for the preparation line (from Table 1)	Increments for $\Delta Q_V = -0.07$ (Tables 1 & 2)	Superconducting bare machine	Incr. for space charge compens. (from Table 3)	Increments for acceleration (from Table 4)	PFW currents for 30 A at 31 GeV
2 PFF1	- 37.04	+ 1.88	- 35.16	+ 0.02	- 33.61	- 68.75
2	- 28.37	- 2.47	- 30.84	+ 3.00	+ 18.14	- 9.70
3	- 8.06	- 2.83	- 10.89	+ 3.46	+ 19.16	+ 11.73
4	- 7.76	- 3.32	- 11.08	+ 4.15	+ 23.53	+ 16.60
5	- 6.49	- 3.10	- 9.59	+ 3.91	+ 29.35	+ 23.67
6	- 2.56	- 3.98	- 6.54	+ 2.86	+ 43.29	+ 39.61
7	- 1.61	- 3.03	- 4.64	+ 1.27	+ 48.65	+ 45.28
8	+ 1.59	- 2.42	- 0.83	+ 2.42	+ 60.94	+ 62.53
9	+ 10.38	- 2.54	+ 7.84	+ 3.36	+ 70.46	+ 81.66
10	+ 10.06	- 2.05	+ 8.01	+ 3.44	+ 49.12	+ 60.57
11	+ 26.12	- 2.44	+ 23.68	+ 4.08	+ 65.70	+ 93.46
12	+ 19.34	- 2.71	+ 16.63	+ 7.74	+ 61.98	+ 86.35
2 PFD1	- 46.92	- 31.03	- 77.95	+ 0.98	- 51.52	-128.49
2	- 2.54	- 15.94	- 18.48	+ 4.20	- 28.64	- 42.92
3	+ 9.67	- 6.33	+ 3.34	+ 4.98	+ 0.15	+ 8.47
4	+ 8.54	- 5.60	+ 2.94	+ 6.81	+ 25.64	+ 35.39
5	+ 6.18	- 5.95	+ 0.23	+ 6.39	+ 25.54	+ 32.16
6	- 5.81	- 5.64	- 11.45	+ 6.45	+ 27.30	+ 22.30
7	- 10.86	- 6.03	- 16.89	+ 6.35	+ 40.46	+ 29.92
8	- 7.32	- 4.18	- 11.50	+ 4.85	+ 52.50	+ 45.85
9	- 12.52	- 2.29	- 14.81	+ 3.05	+ 61.16	+ 49.40
10	- 16.04	- 0.59	- 16.63	+ 0.95	+ 41.34	+ 25.66
11	+ 2.37	- 0.74	+ 1.63	+ 0.57	+ 58.25	+ 60.45
12	- 35.69	- 7.06	- 28.63	- 5.89	+ 52.30	+ 17.98



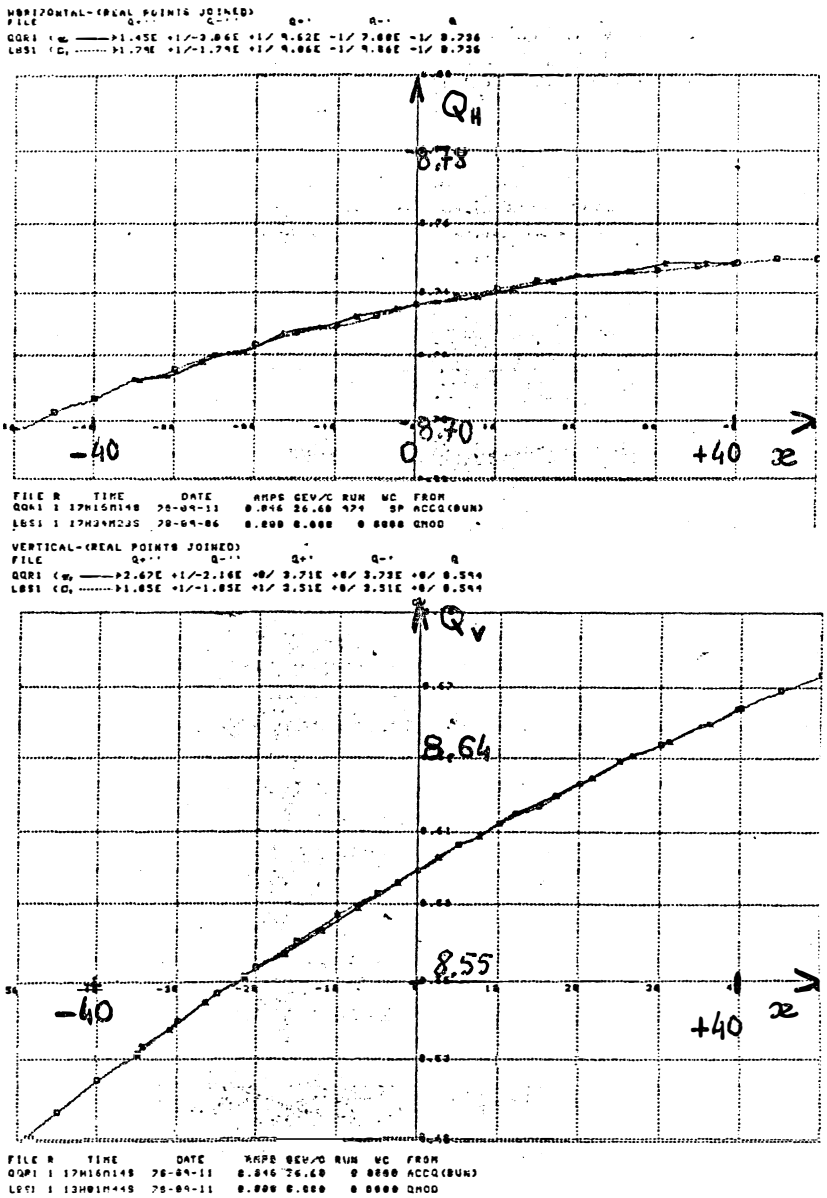
Centre of the preparation line (superconducting bare machine line shifted vertically by 0.07)

Centre of the superconducting bare machine line

Ring 1

(see currents in table 5)

Fig. 1 - Superconducting bare machine line (Ring 1)



Automatic measurement of the preparation line, Ring 1.

It is difficult to distinguish between the measured line and the theoretical line. It is only possible to see the extremity of the theoretica line for x > 40 mm or x < -36 mm, which are the limits of the measurements.

Fig. 2 - Measurement of the preparation line